Fluid Replacement Issues

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Outline

- Water Replacement for Hot Weather
  - Mandatory Drinking
  - Revisions to Guidelines
- Carbohydrate-Electrolyte Beverages
  - Motivation for Inclusion
  - Entry into Field-Feeding System
- Other Commercial Products

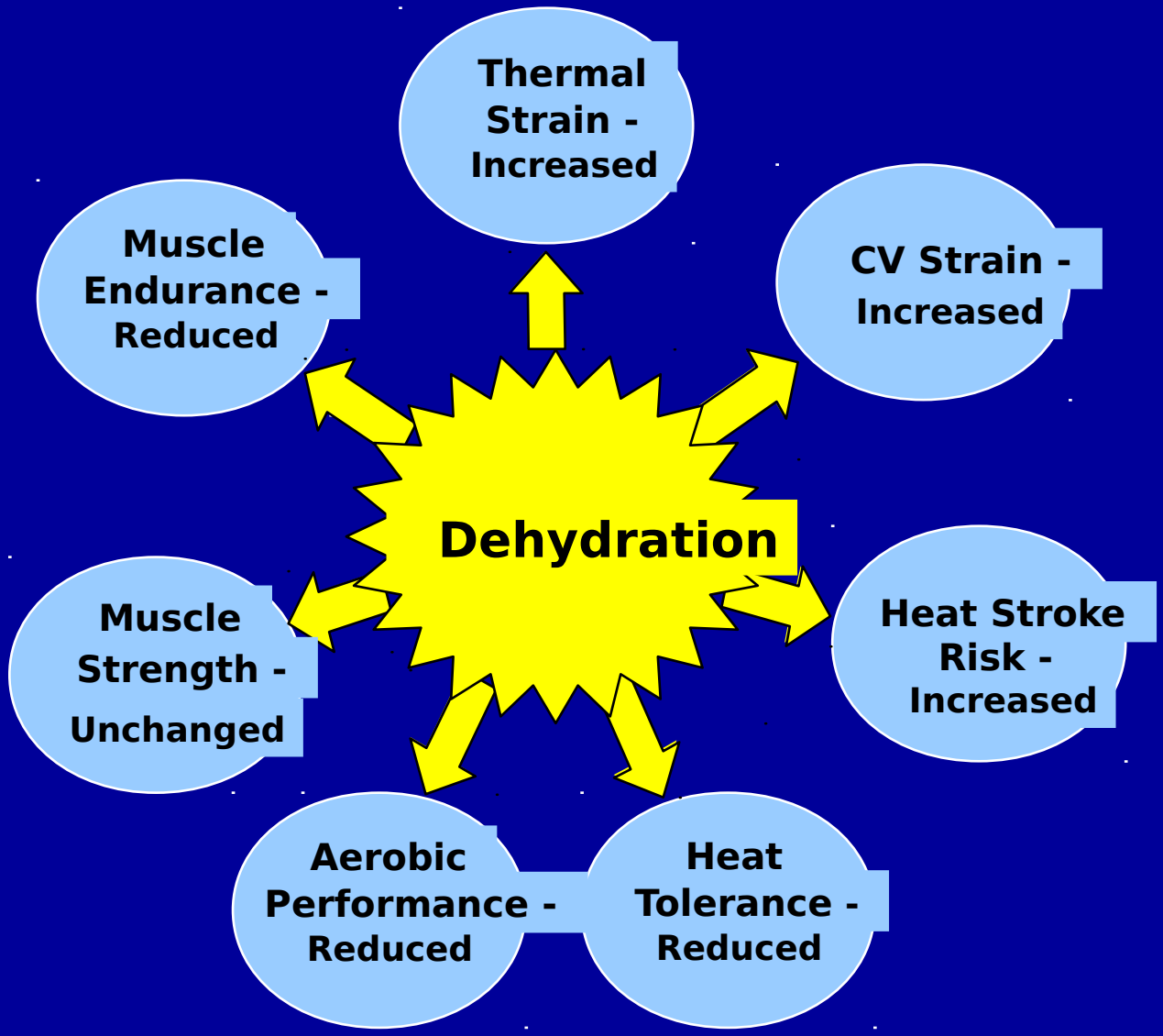
Water and the Military

- Major Logistical Obstacle in Deployment
- Sophisticated Water Delivery/Storage Systems
- Detailed Water Plans for Deployment (FM 10-52)

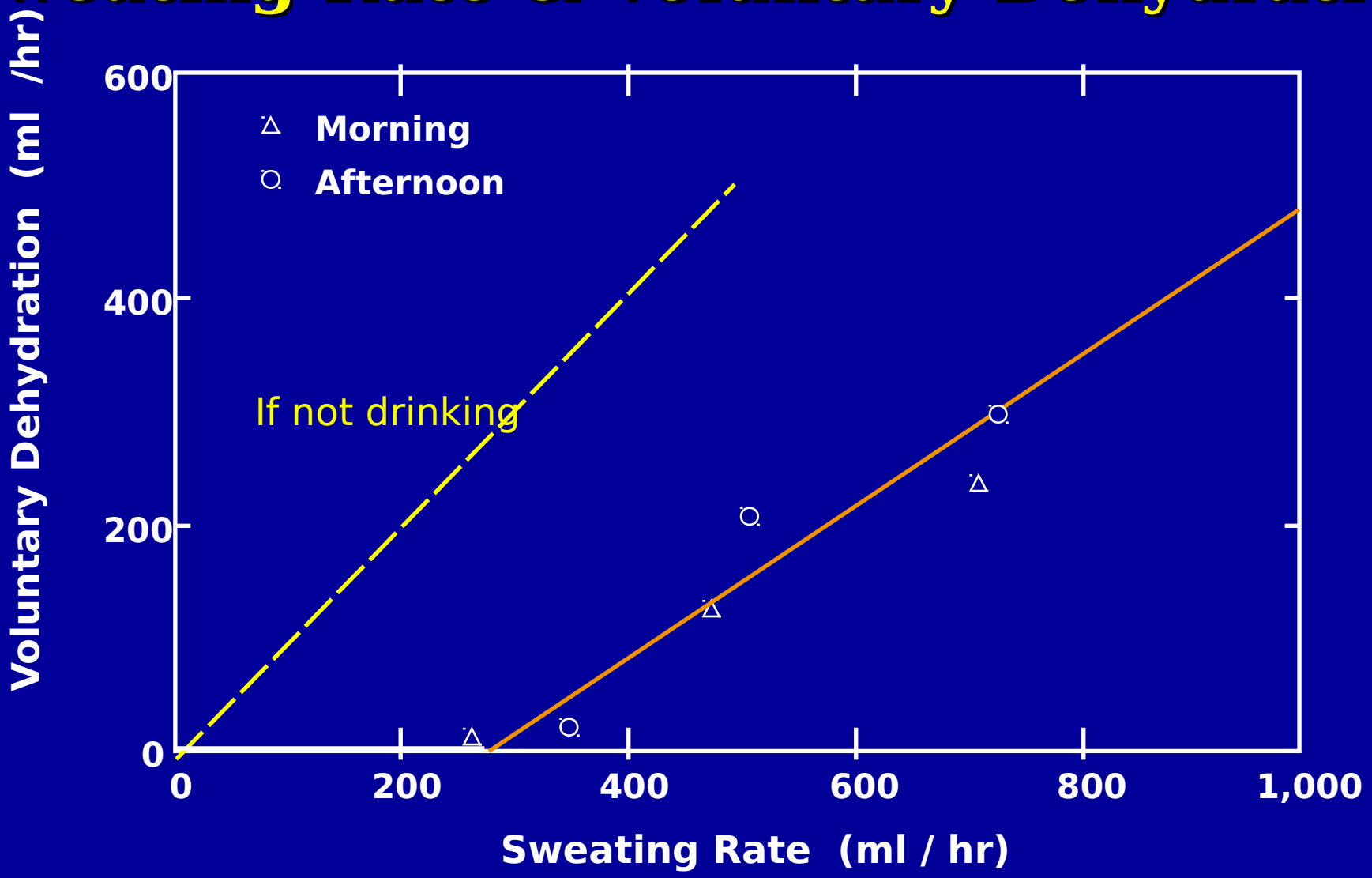
Fluid Replacement Issues

- Hydration is Essential for Health and Performance
- Water Is a Tactical Weapon
- Mandatory/Enforced Drinking Practices

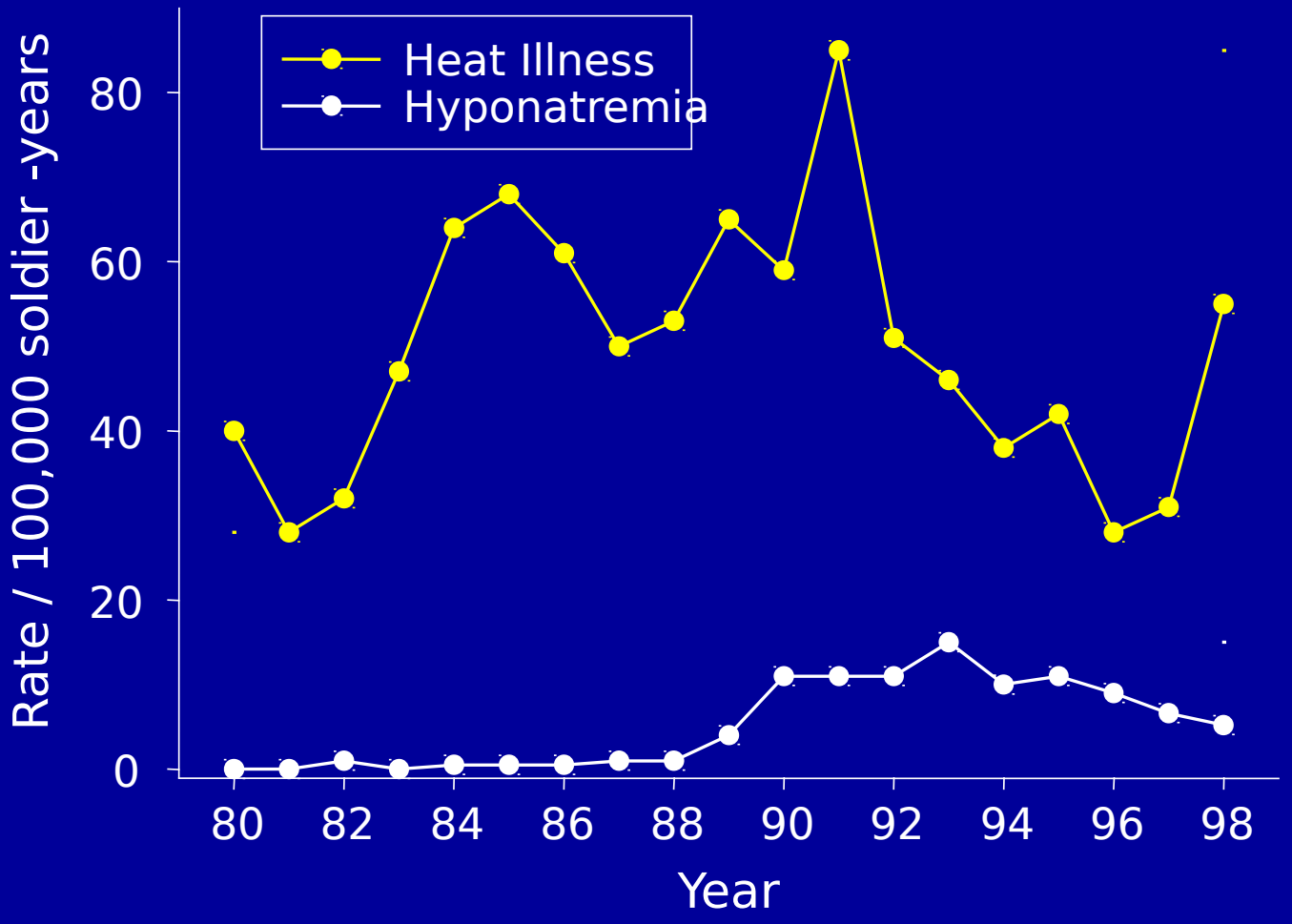
Impact of Dehydration



Sweating Rate & Voluntary Dehydration



Army Hospitalizations due to Heat Illn
Hyposmolality / Hyponatremia 1980 -



MILITARY MEDICINE, 164, 3:234, 1999

Case Report

Death from Hyponatremia as a Result of Acute Water Intoxication in an Army Basic Trainee

Guarantor: MAJ Thomas Garigan, MC USA
Contributors: MAJ(P) Thomas P. Garigan, MC USA*; CPT David E. Ristedt, MC USA†

Several reports during the past 15 years have described hyponatremia as a result of excessive water intake by athletes during endurance races. The high rates of fluid consumption have been attributed to the desire of athletes to prevent heat

8:45 a.m. During marksmanship training, he was sweating profusely and drank two more quarts. The wet bulb globe temperature increased to 100°F by mid morning. He appeared pale,

MILITARY MEDICINE, 163, 11:789, 1998

Case Report

Complications of Fluid Overload in Heat Casualty Prevention during Field Training

*COL Norman C. Reynolds, Jr., MC ARNG**
Howard D. Schumaker, MD MBA†
2LT Susan Feighery, MS USA‡

Several troops evacuated from field training sites as heat casualties were determined to be fluid overload casualties. Common features of this paradoxical syndrome were dilute primary electrolytes with physical exhaustion and muscle weakness after rapid free water intake. A pattern of skipping meals, working in a hot and humid environment, and consuming

CO_2, 21.0 to 32.0 mmol/l; blood urea nitrogen (BUN), 7 to 18 mg/dl; creatinine, 0.6 to 1.3 mg/dl; and Ca^{2+}, 8.7 to 10.5 mg/dl. Evacuations occurred from June to September during annual field training cycles for reservists at Fort McCoy, Sparta, Wisconsin. Environmental conditions involved a temperate climate

Historical Perspective

Upon reaching the Oxus River during the Army's brutal march across the Gedrosian desert, "when plenty of water happened to be found after a hot and thirsty march, most of the men drank so immoderately that the result was fatal to them (Arrian, 6.26)

Curtuis, "Some men gulped water down too greedily and died….the number exceeded the numbers Alexander had lost during any battle" (7.5.15)

from Ruffin, JR. The efficacy of medicine during the campaigns of Alexander the Great. *Mil Med* 157:469, 1992

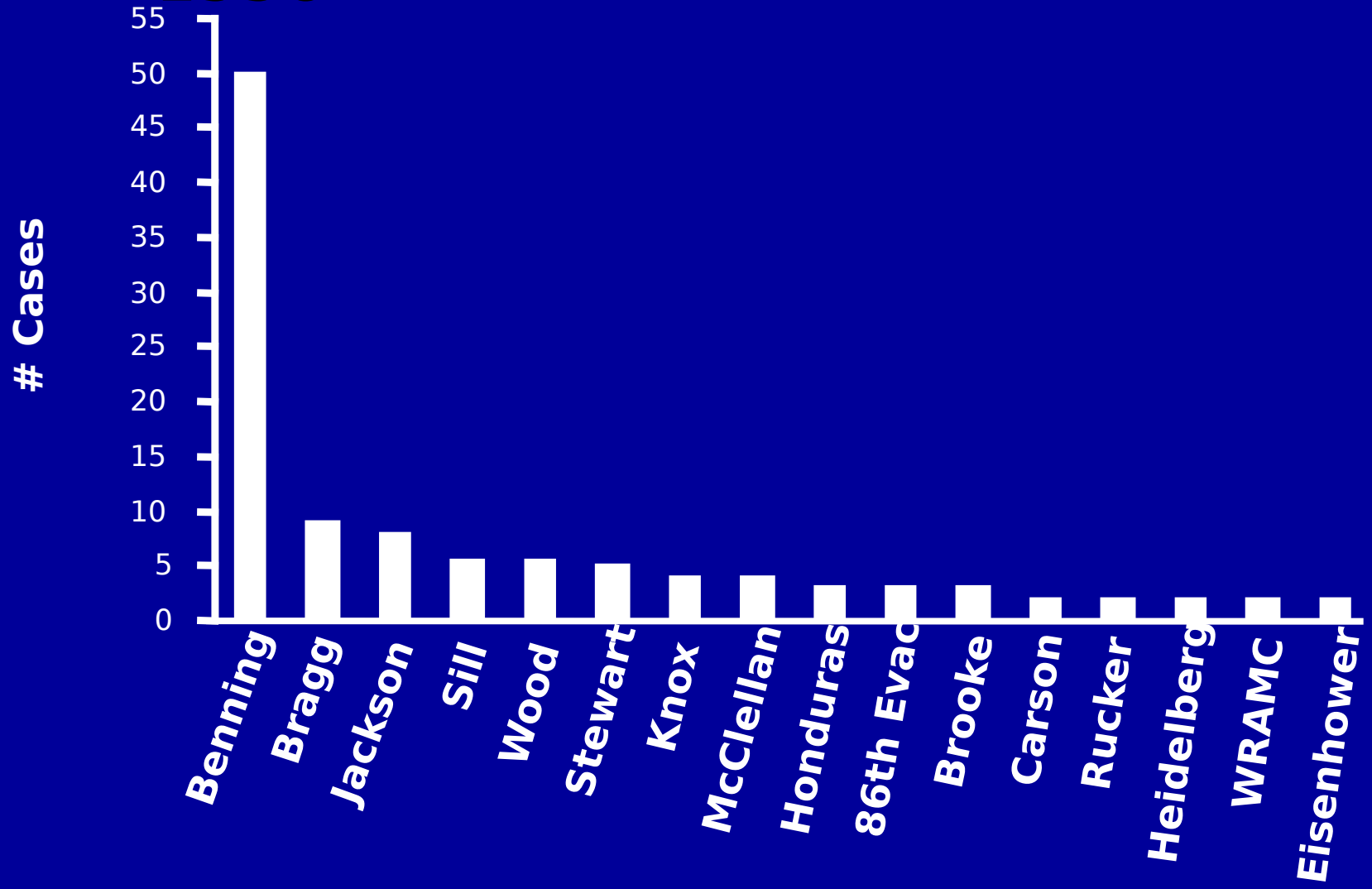
Hyponatremia

- Clinically defined as blood sodium < 135 mEq / liter
- Symptoms are most likely to occur w / rapid dilution of [sodium]
  - Intra -cranial swelling
- Life threatening if sodium < 120 mEq/liter

Hyponatremia - Causes

- Primary cause is excessive drinking of water or hypotonic fluids in relation to sweating losses
- Sodium depletion can contribute
- Inappropriate ADH ??

Hyponatremia Hospitalizations in Active Duty Army, by MTF, 1989-1996



Hyponatremia: Not just an Army Problem

- Epidemiology Data - Parris Island *(Gastaldo & Wenger)*
  - 114 Heat Related Injuries (BMC)
    30 Hospitalized; ~ 150 / 100,000
  - 14 Hyponatremia Cases (BMC)
    12 Hospitalized; ~ 60 / 100,000
- Heat Injury Rate *(Hospitalized)*
  - 1982 - 1992; ~ 70 / 100,000
  - 28 X more hyper- than Hyponatremia

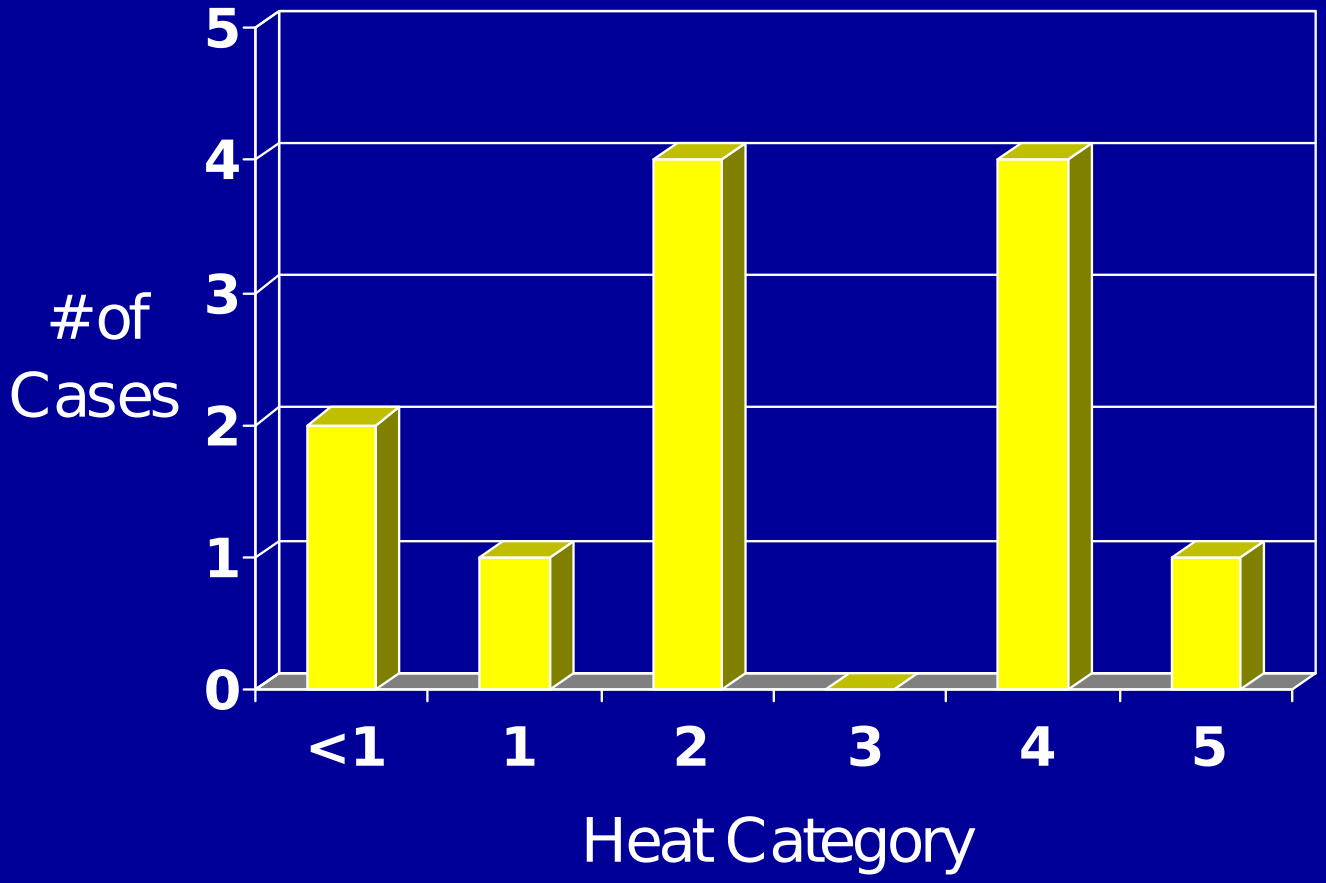
The Crucible

- 55 h Sustained Operation
- 5450 kcal/day
- 5 MRE per 2 soldiers (1400 kcal/day)
- 3 g Na^+ in / day
- 8.4 g Na+ out / day

Hyponatremia Facts: Ft. Benning 1996-97 (14 hospitalized cases)

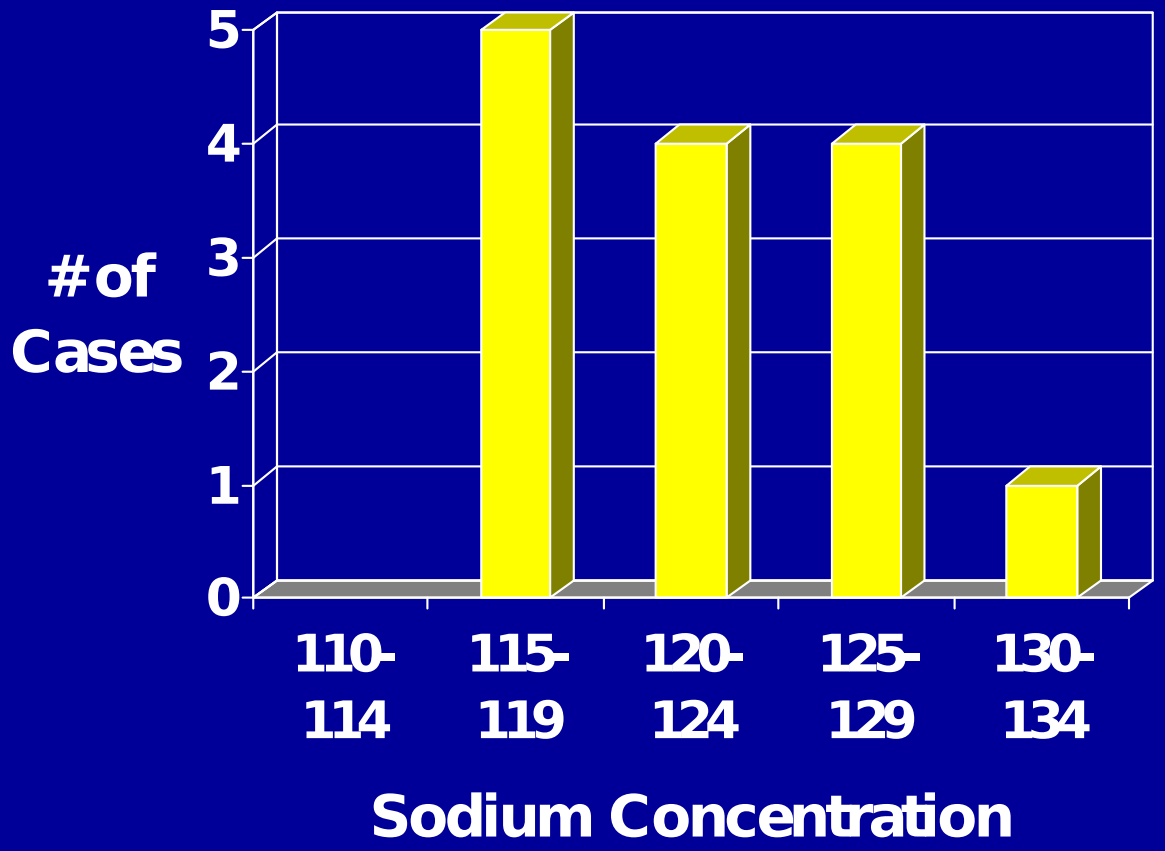
- All cases from student population
- Most cases - first four weeks of training
- Most cases - good health, 5 reported illness within past 3 days

Environmental Conditions



Serum Sodium

122 ± 5 mEq / liter



Excessive Water Intake - 4 Cases

Water Intake, Qt/h	Activity	WBGT, max	~ Sweating Rate, Qt/h
>2	Range	88	0.75
1	Inf. Skill (light work)	84.5	0.5
2	Range	91.5	1
1	8 mi Road March	~56	0.5

- All cases drinking in excess of 1 qt/h; 6 of 9 drank >2 qt/h

Hyponatremia Facts: Ft. Benning 1996-97 (14 hospitalized cases)

- Symptoms often treated by forced hydration
  - Case A: After complaining of nausea - instructed to drink more water (~7 liters) - after vomiting returned to barracks - seizure
  - Case B: After vomiting, drank 10-12 qts in 1.5 h - taken to hospital
  - Case C: After complaining of nausea and vomiting - drank 10-14 qts over 2 hrs - repeatedly vomited - hospital - death

Hyponatremia Solutions: Ft. Benning

- Revise Water Replacement Guidelines for Hot Weather Training
- Revise Medical Evacuation Operating Procedures

EPICON Recommendations

- Draft Rehydration Guidance based on Heat Stress Category & Physical Activity Level
- New Upper Limit for Hourly, Treatment & Daily Rehydration
- New Medical Evacuation Criteria

Fluid Replacement Guidelines for Warm Weather Training (Average Acclimated Soldier wearing BDU in Hot Weather).

Heat Category	WBGT Index, °F	Easy Work		Moderate Work		Hard Work	
		Work /Rest	Water Intake, Qt/h	Work /Rest	Water Intake, Qt/h	Work /Rest	Water Intake, Qt/h
1	78-81.9	NL	½	NL	¾	40/20 min	¾
2	82-84.9	NL	½	50/10 min	¾	30/30 min	1
3	85-87.9	NL	¾	40/20 min	¾	30/30 min	1
4	88-89.9	NL	¾	30/30 min	¾	20/40 min	1
5	> 90	50/10 min	1	20/40 min	1	10/50 min	1

- The work:rest times and fluid replacement volumes will sustain performance and hydration for at least 4 h of work in the specified heat category. Individual water needs will vary ± ¼ qt/h.
- NL= no limit to work time per hour. Rest means minimal physical activity (sitting or standing) and should be accomplished in shade if possible.
- **Caution: Hourly fluid intake should not exceed 1½ quarts.**
- **Daily fluid intake should not exceed 12 quarts.**
- MOPP gear adds 10°F to WBGT Index.
- Examples:

Easy Work	Moderate Work	Hard Work
• Weapon Maintenance • Walking Hard Surface at 2.5 mph, ≤30 lb Load • Manual of Arms • Marksmanship Training • Drill and Ceremony	• Walking Loose Sand at 2.5 mph, No Load • Walking Hard Surface at 3.5 mph, ≤40 lb Load • Calisthenics • Patrolling • Individual Movement Techniques, i.e. low crawl, high crawl • Defensive Position Construction • Field Assaults	• Walking Hard Surface at 3.5 mph, ≥40 lb Load • Walking Loose Sand at 2.5 mph with Load

Fluid Replacement Guidelines for Warm Weather Training (Average Acclimated Soldier Wearing BDU, Hot Weather)

Heat Category	WBGT Index, °F	Easy Work		Moderate Work		Hard Work	
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2	82-84.9	NL	½	50/10 min	¾	30/30 min	1
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4	88-89.9	NL	¾	30/30 min	¾	20/40 min	1
5	> 90	50/10 min	1	20/40 min	1	10/50 min	1

Water Replacement Guidelines - Bullet Statements

- The work:rest times and fluid replacement volumes will sustain performance and hydration for at least 4 h of work in the specified heat category. Individual water needs will vary ± 1/4 qt/h
- NL = no limit to work time per hour.
- Rest means minimal physical activity (sitting or standing), accomplished in the shade if possible
- Caution: Hourly fluid intake should not exceed 1½ quarts
- Daily fluid intake should not exceed 12 quarts
- Wearing body armor add 5°F to WBGT Index
- Wearing MOPP overgarment add 10°F to WBGT Index

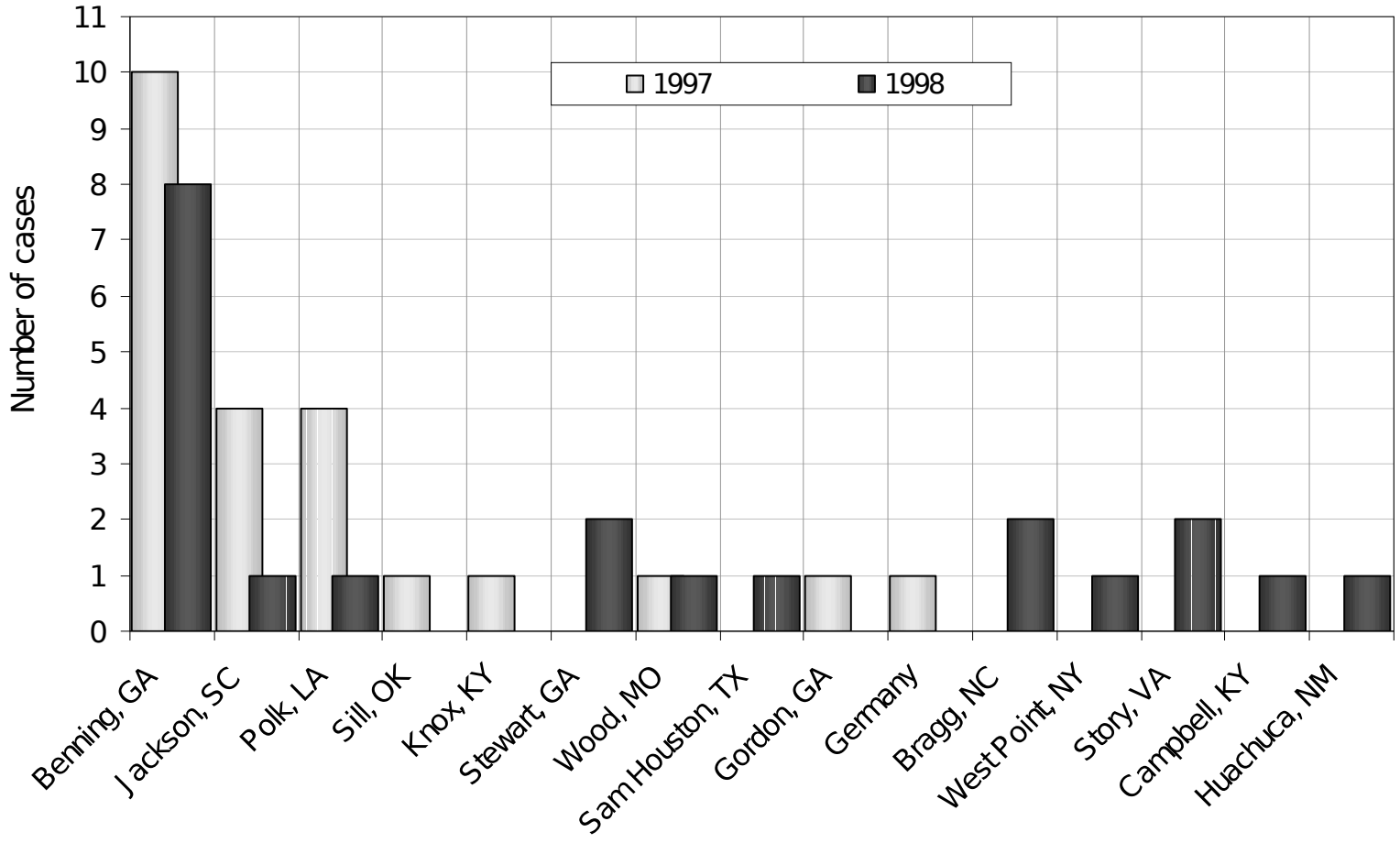
Fluid Replacement Guidelines - Examples

Easy Work	Moderate Work	Hard Work
• Weapon Maintenance • Walking Hard Surface at 2.5 mph, ≤30 lb Load • Manual of Arms • Marksmanship Training • Drill and Ceremony	• Walking Loose Sand at 2.5 mph, No Load • Walking Hard Surface at 3.5 mph, ≤40 lb Load • Calisthenics • Patrolling • Individual Movement Techniques, i.e. low crawl, high crawl • Defensive Position Construction • Field Assaults	• Walking Hard Surface at 3.5 mph, ≥40 lb Load • Walking Loose Sand at 2.5 mph with Load

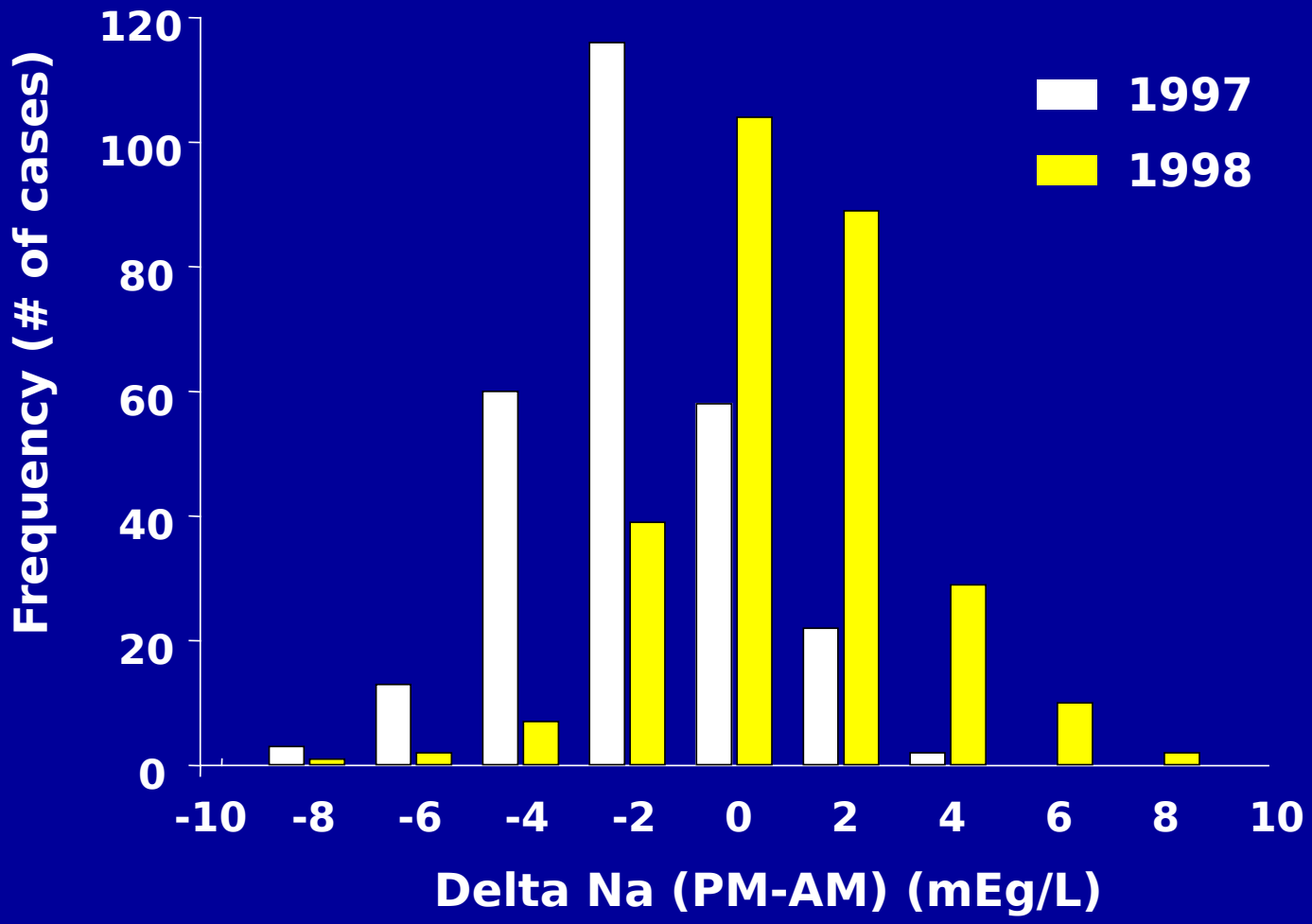
Medical Evacuation Criteria

- 2 Cases of Emesis
- 1 h Rehydration (2 qts; 1 qt per 30 min) with Limited Improvement
- General Deterioration

Hyponatremia/hyposmolalty cases, spring-summer (May-September) 1997-1998, active duty soldiers/cadets, by location of medical treatment facility



Change in Serum Na from Morning to Ev



Discriminating Symptoms Of Hyponatremia

- Emesis, (repeated vomiting)
- History of Rehydration
- Urine Output
- Lack of Rapid Recovery (1 h)
- Seizure
- Abdominal Distention

Are the correct questions being asked?

- What Was Prior Rehydration History?
- Do They Feel That Their Stomach Is Full From Drinking?
- Is Their Abdomen Bloated?

Prevention

- Education
  - Don’t Over-drink
  - Eat Regular Meals
- Doctrine
  - Sensible Guidance Regarding Fluid Replacement
  - Conservative Evacuation Criteria
- Provision of Electrolyte Source When Food Is Limited or Unlikely to Be Consumed

CE Beverage Facts

- Carbohydrate electrolyte beverages (optimal formulation)
  - 10 - 30 mEq / L sodium
  - 2 - 5 mEq / L potassium
  - Chloride as only anion
  - 5% - 10 % CHO
- Military use merited (National Academy of Sciences, 1994)
  - Conditions of high sweat & electrolyte losses
  - During heavy work to maintain blood glucose
  - Rapid rehydration after exercise
- CE beverages usually same as water

Commercial Products

PowerBar

CLIF BAR

POWERADE

Army Products

Advantages for Military

- Supplemental Calorie Source
  - Deployed Soldiers Generally Under Eat
  - CHO Intake Borderline
- Electrolyte Source
- ORS during GI illness

Risks

- Proper Sanitation
  - Mold Growth
  - Bacterial Growth
- Water for Wounds - Contaminated Water
- Compromise Food Intake?

Prevention

- Frequent Cleaning of Water Containers
  - Daily Rinsing w/ Clear Water
  - Sanitize 1x /week
  - Sanitize Upon Return From Field
- Never Contaminate Both Canteens

Glycerol Solutions for Hyperhydration

- Commercial Products Available
  - Pro Hydrator
- Suggested Benefit
  - Sustainable Hyperhydration
  - Reduced Body Temperatures
  - Improved Performance

Glycerol Solutions for Hyperhydration

- Demonstrated Effects
  - Sustainable Hyperhydration
  - Delayed Onset of Hypohydration
  - Temperature Effects Equivocal
  - Performance Effects Equivocal
- Risks
  - GI Upset
  - Emesis

Summary

- Water Discipline Is an Essential Component For Minimizing Heat Casualties
- Fluid Overload Can Make Soldiers Sick
- Revisions to Fluid Replacement Recommendations Have Been Implemented - Evaluation Is Underway
- Carbohydrate Electrolyte Beverages Are Becoming More Available to Troops - Medical Personnel Need to Be Aware of the Benefits and Risks of Their Use